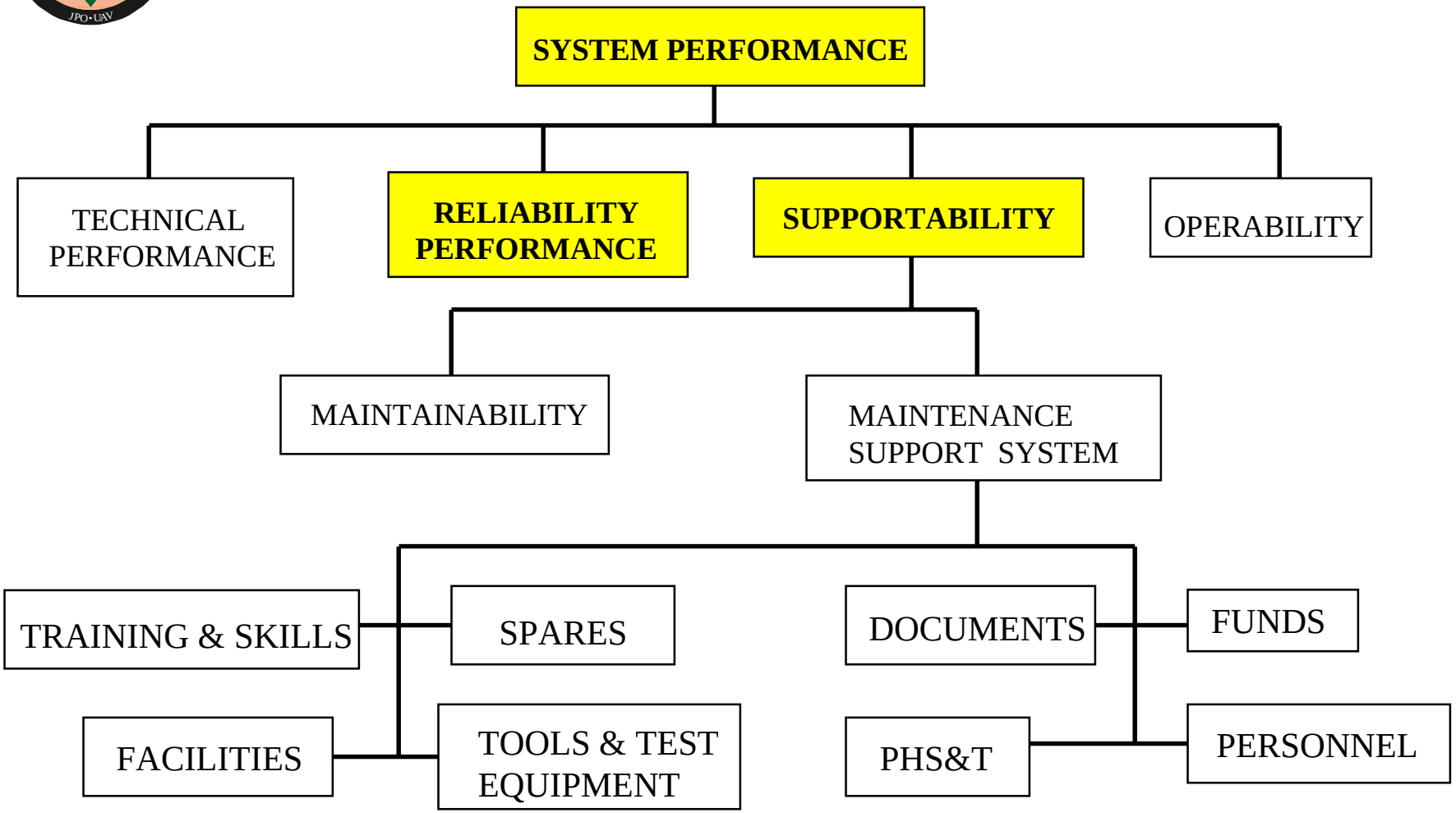
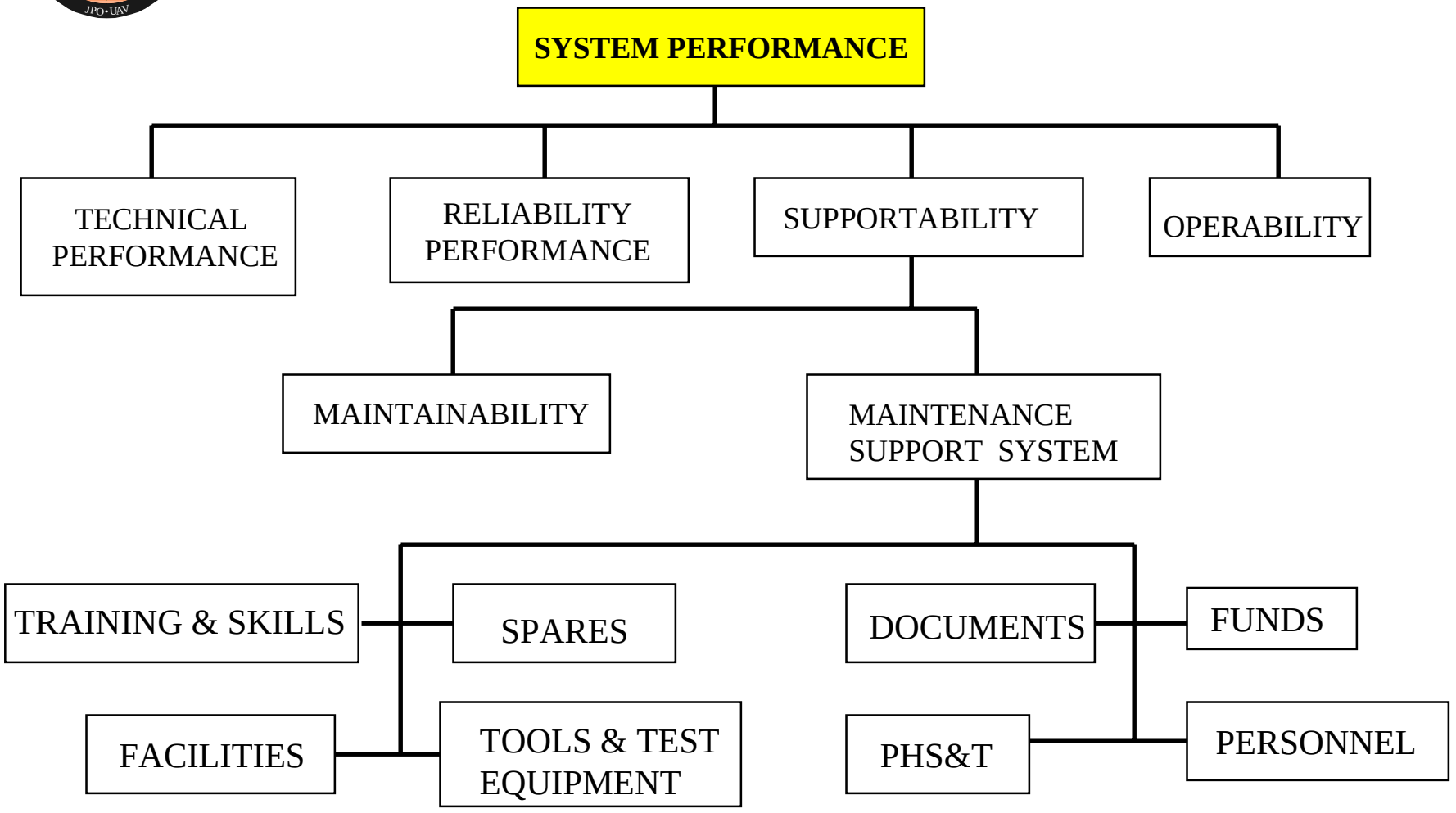
INTEGRATED LOGISTICS SUPPORT

PRELIMINARY DESIGN REVIEW

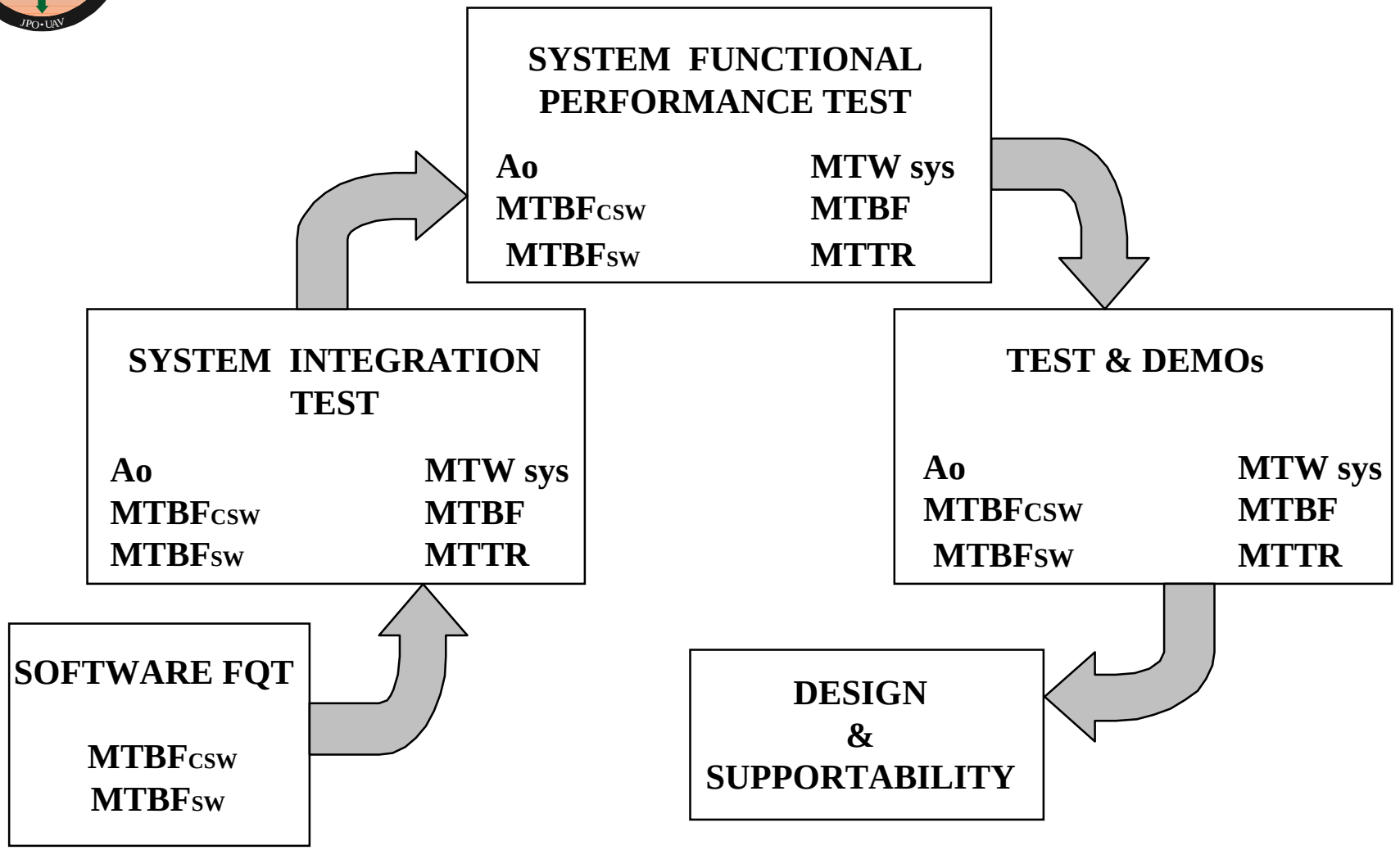
INTEGRATED LOGISTICS SUPPORT DESIGN



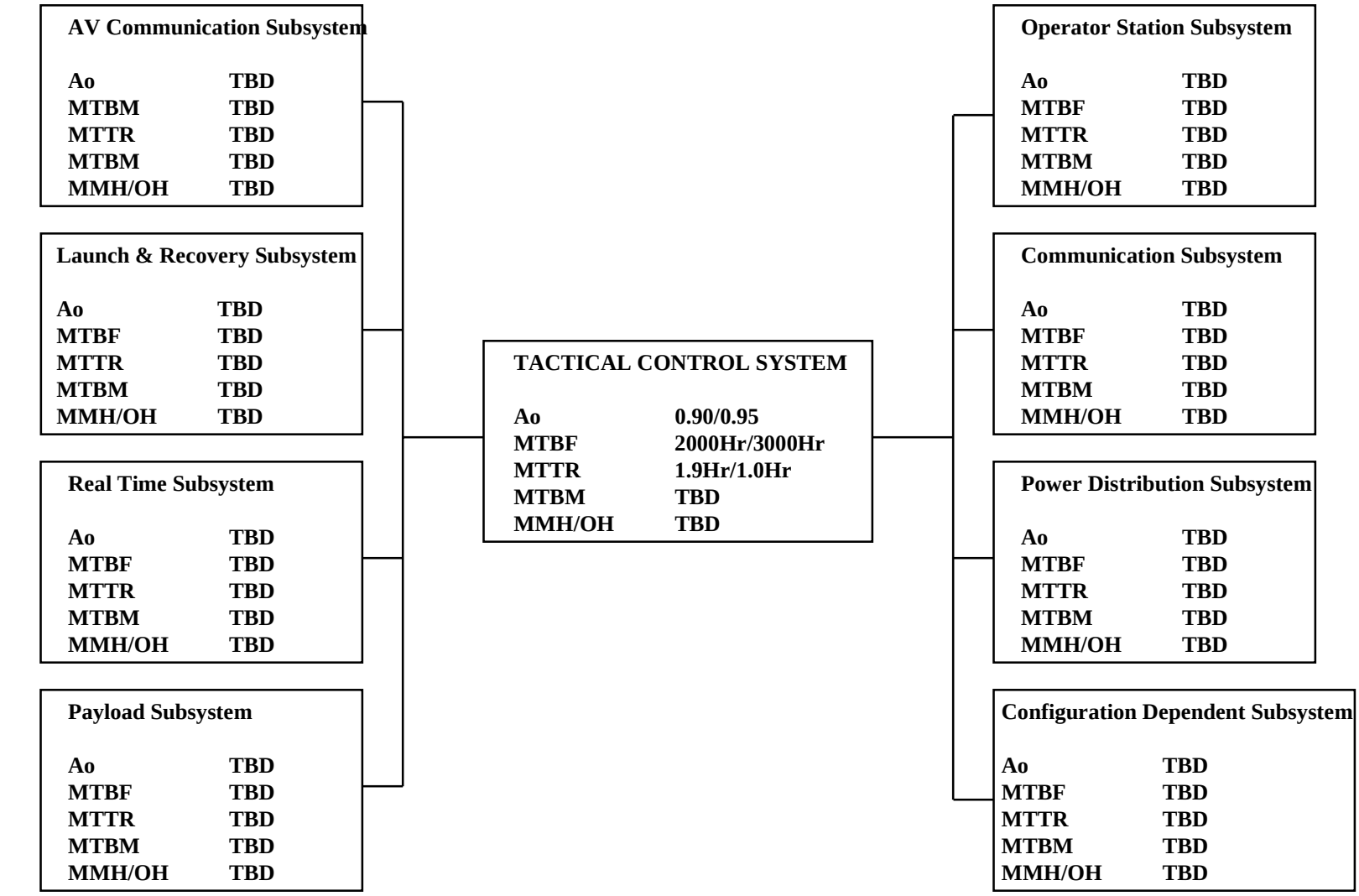
INTEGRATED LOGISTICS SUPPORT DESIGN



DATA COLLECTION



READINESS


AV Communication Subsystem
Ao TBD
MTBM TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Launch & Recovery Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Real Time Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Payload Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
TACTICAL CONTROL SYSTEM
Ao 0.90/0.95
MTBF 2000Hr/3000Hr
MTTR 1.9Hr/1.0Hr
MTBM TBD
MMH/OH TBD
Operator Station Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Communication Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Power Distribution Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD
Configuration Dependent Subsystem
Ao TBD
MTBF TBD
MTTR TBD
MTBM TBD
MMH/OH TBD

READINESS
(Operational Availability- A_O)

$$A_O = \frac{MTBF}{MTBF + MTTR + MTW_{SYS}}$$

MTBF - Mean Time Between System Failure
MTTR - Mean Time To Repair
MTW_{SYS} - Mean Time Waiting for spare
(Includes logistics delay time and administrative delay time)

READINESS
(Operational Availability- A_o)

$$A_O = \frac{69.4}{69.4 + 0.8 + 0} = 98.8\%$$

JWID 97
MTBF - 69.4 hours
MTTR - 0.8 hours
MTW_{SYS} - 0

A_O = 90.0 % Threshold

A_O = 95.0 % Objective

Note: TFXXI, Division XXI and Fleet Ex data being reviewed

JWID 97 DATA COLLECTION

Week #	Date	Turn-on	Turn-off	Demand Time	Down Time	Time Operated	Operational Availability
1	7/14/97	7:00	16:50	9:50	0:08	9:42	98.64%
	7/15/97	6:57	16:25	9:28	0:00	9:28	100.00%
	7/16/97	7:05	16:30	9:25	0:00	9:25	100.00%
	7/17/97	7:00	17:00	10:00	0:00	10:00	100.00%
	7/18/97	7:00	16:30	9:30	1:30	8:00	84.21%
For the week				48:13:00	1:38	46:35:00	96.30%
2	7/21/97	6:10	17:00	10:50	0:00	10:50	100.00%
	7/22/97	7:00	16:40	9:40	0:00	9:40	100.00%
	7/23/97	7:00	16:30	9:30	0:00	9:30	100.00%
	7/24/97	6:00	17:00	11:00	0:00	11:00	100.00%
	7/25/97	7:30	17:55	10:25	0:00	10:25	100.00%
For the week				51:25:00		51:25:00	100.00%
3	7/28/97	6:45	17:45	11:00	0:00	11:00	100.00%
	7/29/97	7:00	17:00	10:00	0:00	10:00	100.00%
	7/30/97	7:00	17:50	10:50	0:00	10:50	100.00%
	7/31/97	7:00	16:45	9:45	0:00	9:45	100.00%
For the week				41:35:00		41:35:00	100.00%

Mean Time Between Failure for Critical Software ($MTBF_{CSW}$)

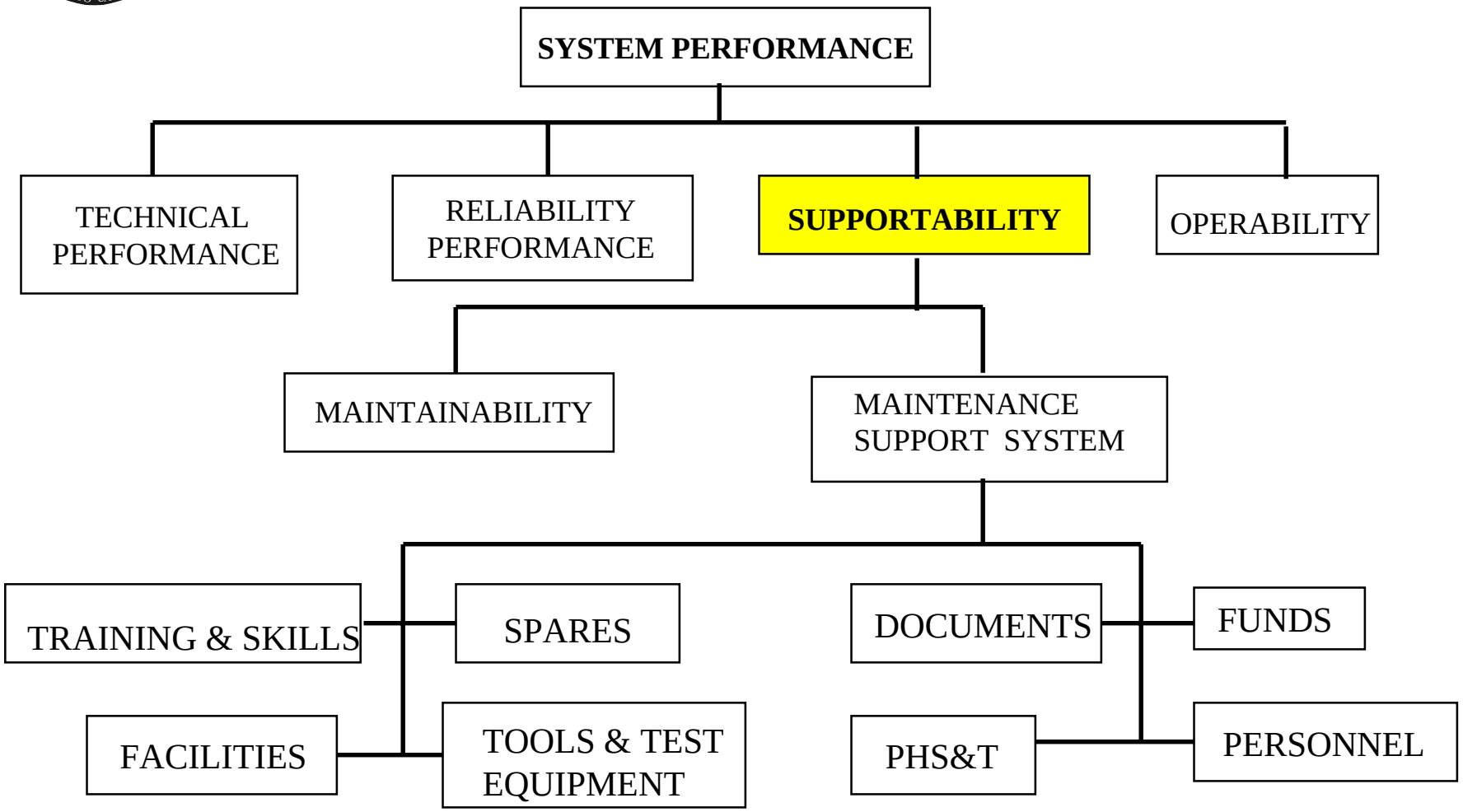
$$MTBF_{CSW} = \frac{\text{\# Operating Hours w /o Priority 1/2}}{\text{\# Total Operating Hours}}$$

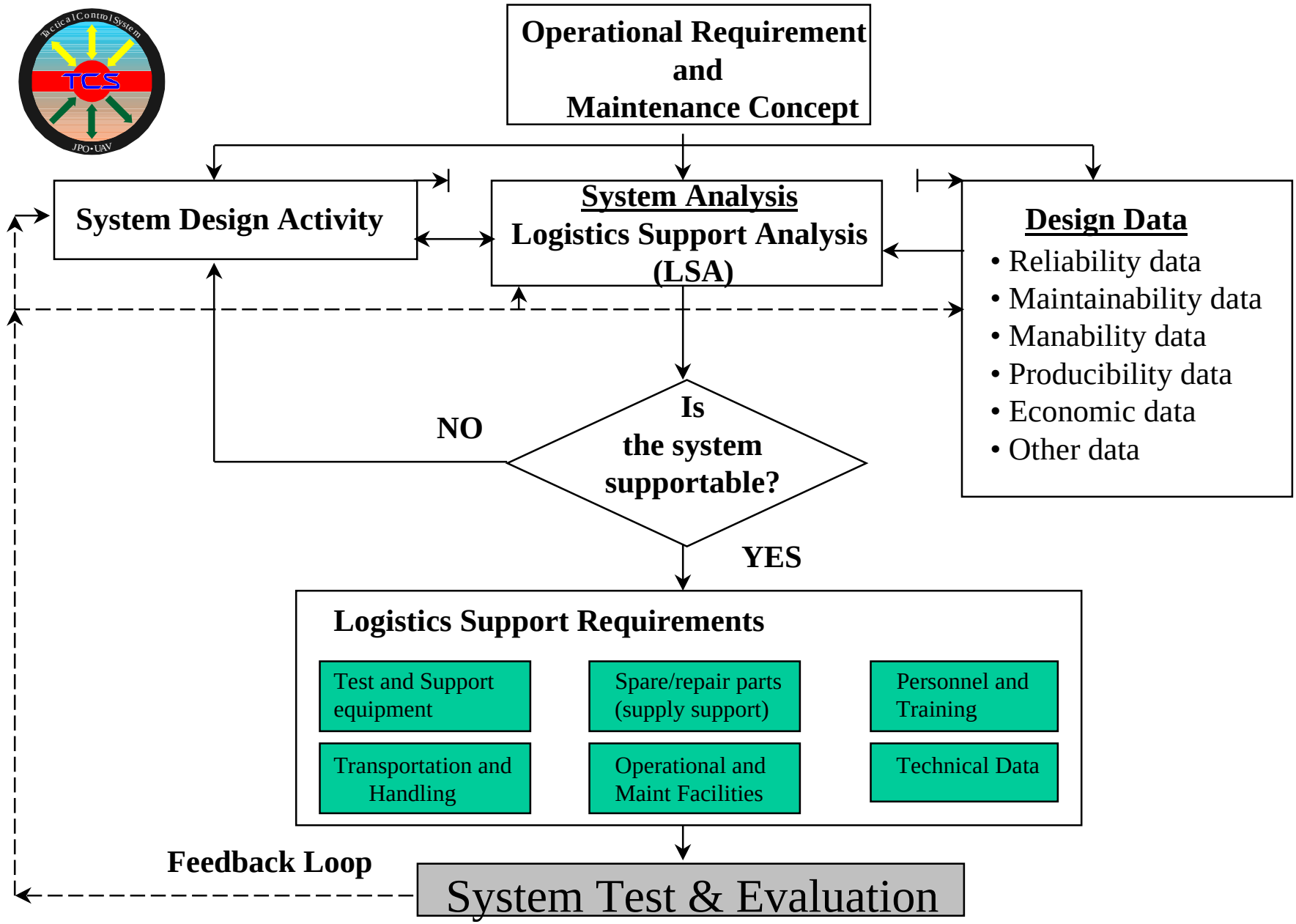
Critical:

Priority 1: **An error that prevents the accomplishment of an operational or mission essential function in accordance with official requirements (e.g., causes a program to stop)or that interferes with an operator to the extent that the operator prevents the accomplishment of an operational or mission essential function or jeopardizes personnel safety**

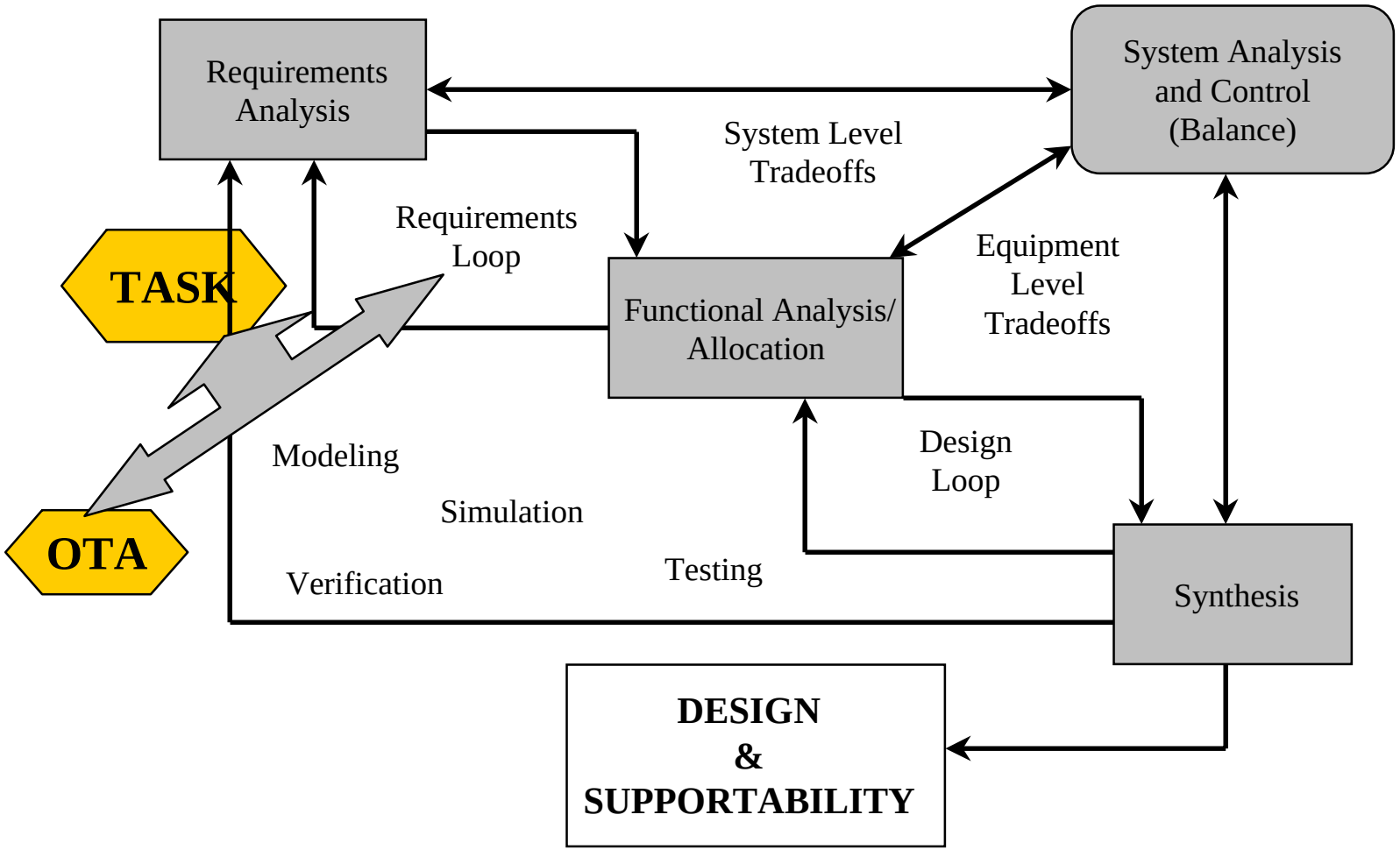
Priority 2: **An error that (a) adversely affects the accomplishment of an operational or mission essential function in accordance with official requirements so to degrade performance and for which no alternative workaround solution exists or (b) that interferes with the operator to the extent that the operator adversely affects the accomplishment of an operational or mission essential function so as to degrade performance and for which no alternative workaround solution exists. (Reloading or restarting the program is not an acceptable workaround solution**

INTEGRATED LOGISTICS SUPPORT DESIGN




Operational Requirement and Maintenance Concept
System Design Activity
System Analysis
Logistics Support Analysis (LSA)
Design Data
• Reliability data
• Maintainability data
• Manability data
• Producibility data
• Economic data
• Other data
Is the system supportable?
NO
YES
Logistics Support Requirements
Test and Support equipment
Spare/repair parts (supply support)
Personnel and Training
Transportation and Handling
Operational and Maint Facilities
Technical Data
Feedback Loop
System Test & Evaluation

INTEGRATED LOGISTICS SUPPORT DESIGN



MAJOR LEVELS OF MAINTENANCE

CRITERIA	ORGANIZTIONAL MAINTENANCE	INTERMEDIATE MAINTENANCE		DEPOT MAINTENANCE
Done where?	At the system operating site or wherever the prime equipment is located	Mobile or semi-mobile units	Fixed units	Depot facility
		Truck, van, portable shop, or equivalent	Fixed field shop	Specialized repair activity
Done by whom?	System/equipment operating personnel (low maintenance skills)	Personnel assigned to mobile semi-mobile, or fixed units (intermediate maintenance skills		Depot facility personnel (mix of intermediate skills and high maintenance skills)
On whose equipment?	Using organization's equipment	Equipment owned by using organization		
Type of work accomplished	Visual inspection Operational checkout Minor servicing External adjustments Removal and replacement of some components	Detailed inspection and system checkout Major servicing Major equipment repair and modifications Complicated adjustments Limited calibration Overload from organizational level of maintenance		Complicated depot adjustments Complex equipment repairs and modifications Overhaul and rebuild Detailed calibration Supply support Overload from intermediate level of maintenance

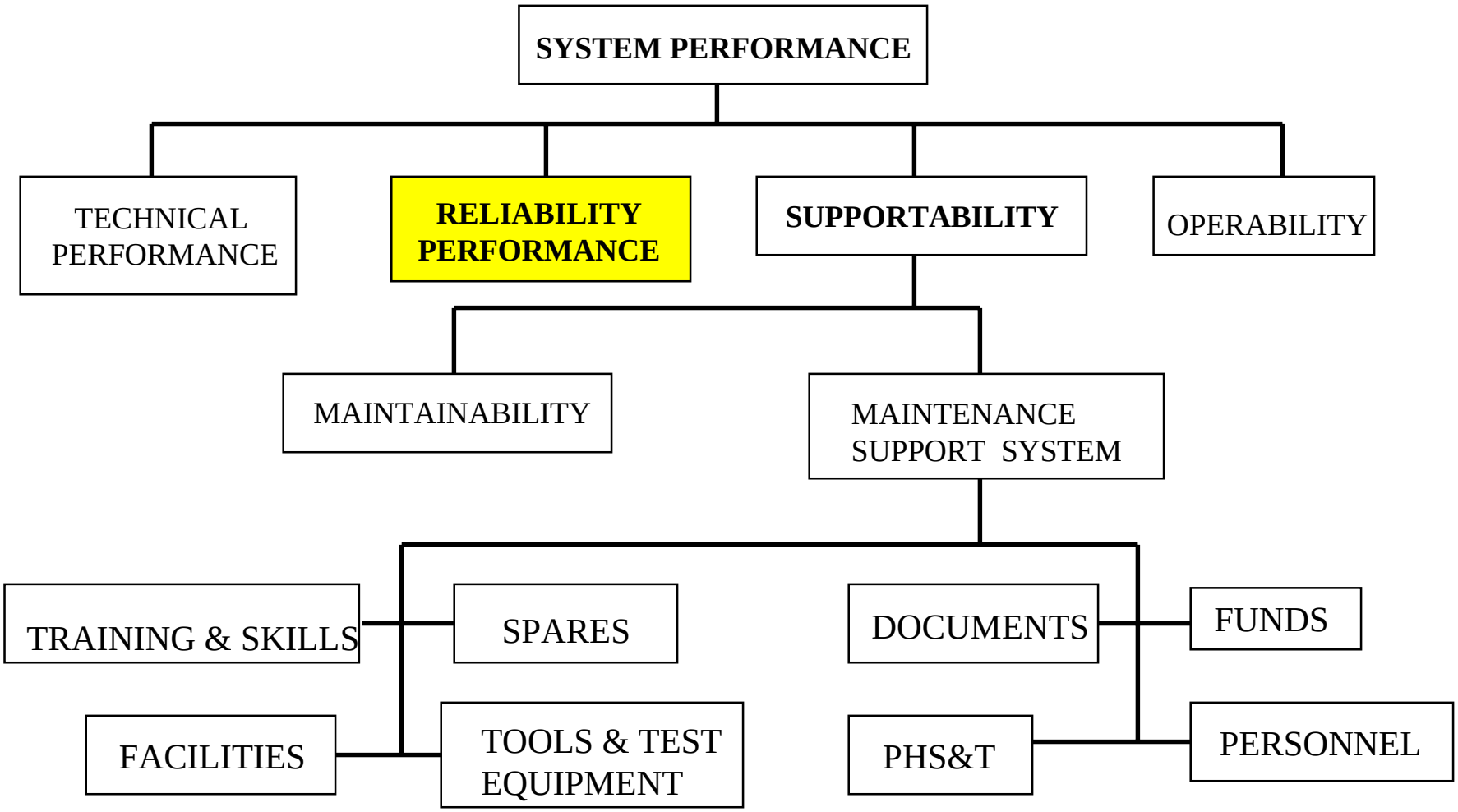
HARDWARE PROVISIONING

HWCI	PHILOSOPHY
TAC 4	Organizational - Depot
VME	Organizational - Depot
Datalink Control Module	Organizational - Depot
IBLS	TBD
UAV CARS	Organizational - Depot
Real Time Computer	TBD
Manual Control	TBD
SAR Processor	Organizational - Depot
Digital Linear Tape Drive	TBD
Redundant Array of Inexpensive Disks	TBD
Link Manager Assembly	Organizational - Depot
* This will be look at for each item	

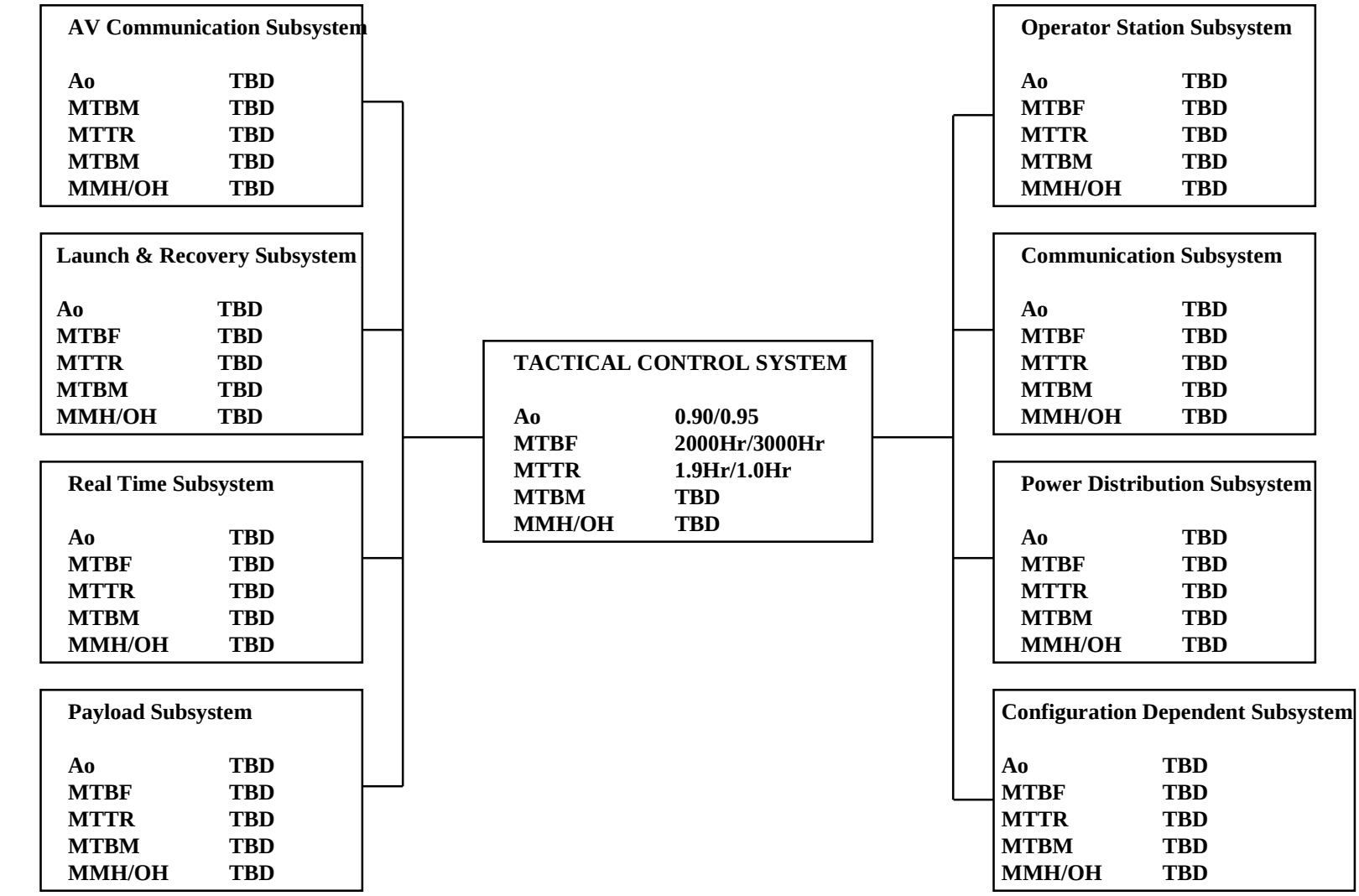
HARDWARE PROVISIONING

HWCI	Ao	MTBF	MTTR	HWCI	Ao	MTBF	MTTR
Datalink Terminal	TBD	TBD	TBD	Non-Real Time Computer	TBD	TBD	TBD
Antenna Assembly	TBD	TBD	TBD	Video Support	TBD	TBD	TBD
Datalink Control Module	TBD	TBD	TBD	Operator Output	TBD	TBD	TBD
IBLS	TBD	TBD	TBD	Operator Input	TBD	TBD	TBD
UAV CARS	TBD	TBD	TBD	External Storage	TBD	TBD	TBD
Real Time Computer	TBD	TBD	TBD	Printer	TBD	TBD	TBD
Manual Control	TBD	TBD	TBD	Intercom Equipment	TBD	TBD	TBD
SAR Processor	TBD	TBD	TBD	C4I Support	TBD	TBD	TBD
Digital Linear Tape Drive	TBD	TBD	TBD	Communication Equipment	TBD	TBD	TBD
Redundant Array of Inexpensive Disks	TBD	TBD	TBD	Uninteruptible Power Supply	TBD	TBD	TBD
Link Manager Assembly	TBD	TBD	TBD	Power Distribution	TBD	TBD	TBD

INTEGRATED LOGISTICS SUPPORT DESIGN



READINESS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Configuration Dependent Subsystem
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MTBF TBD
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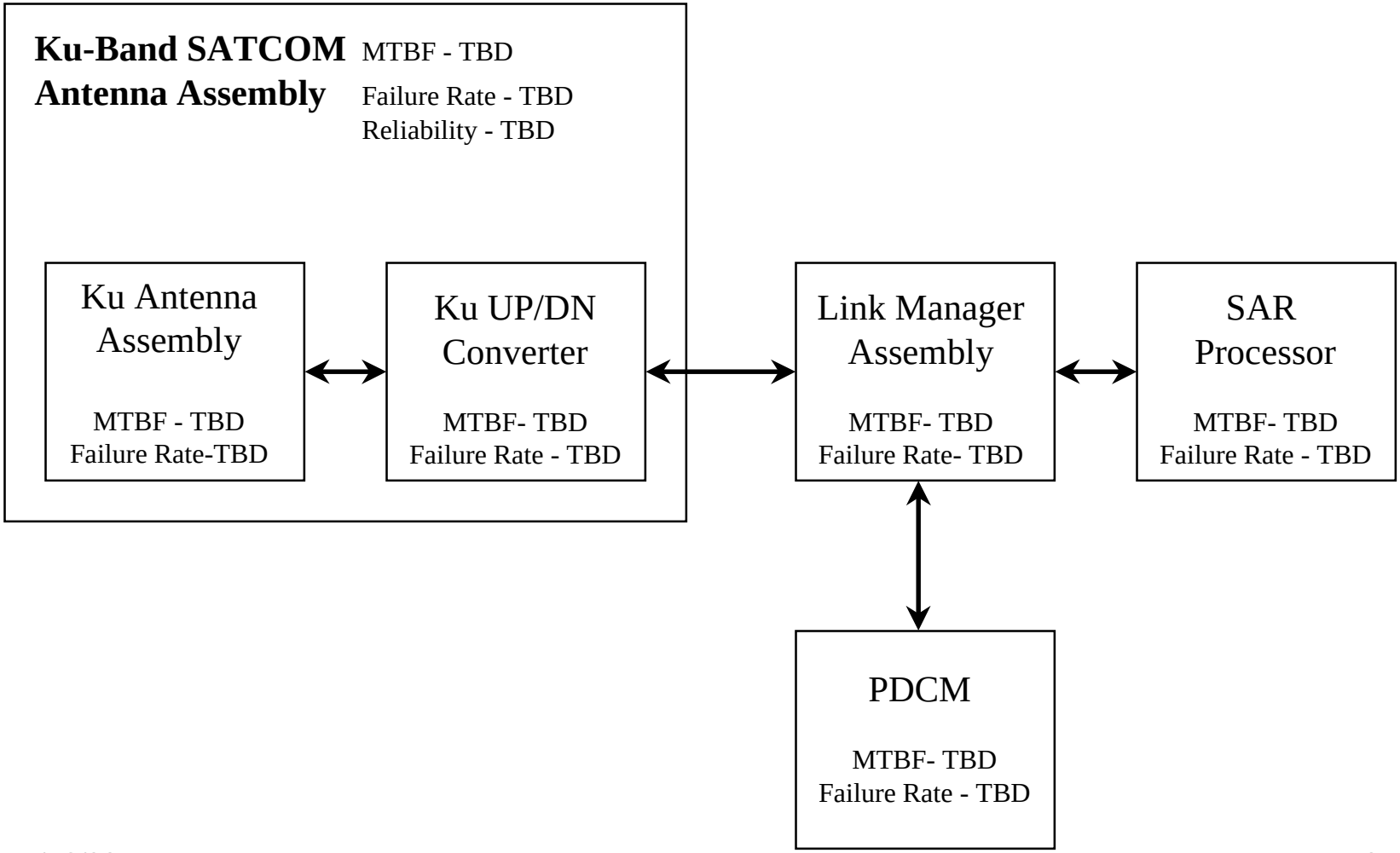
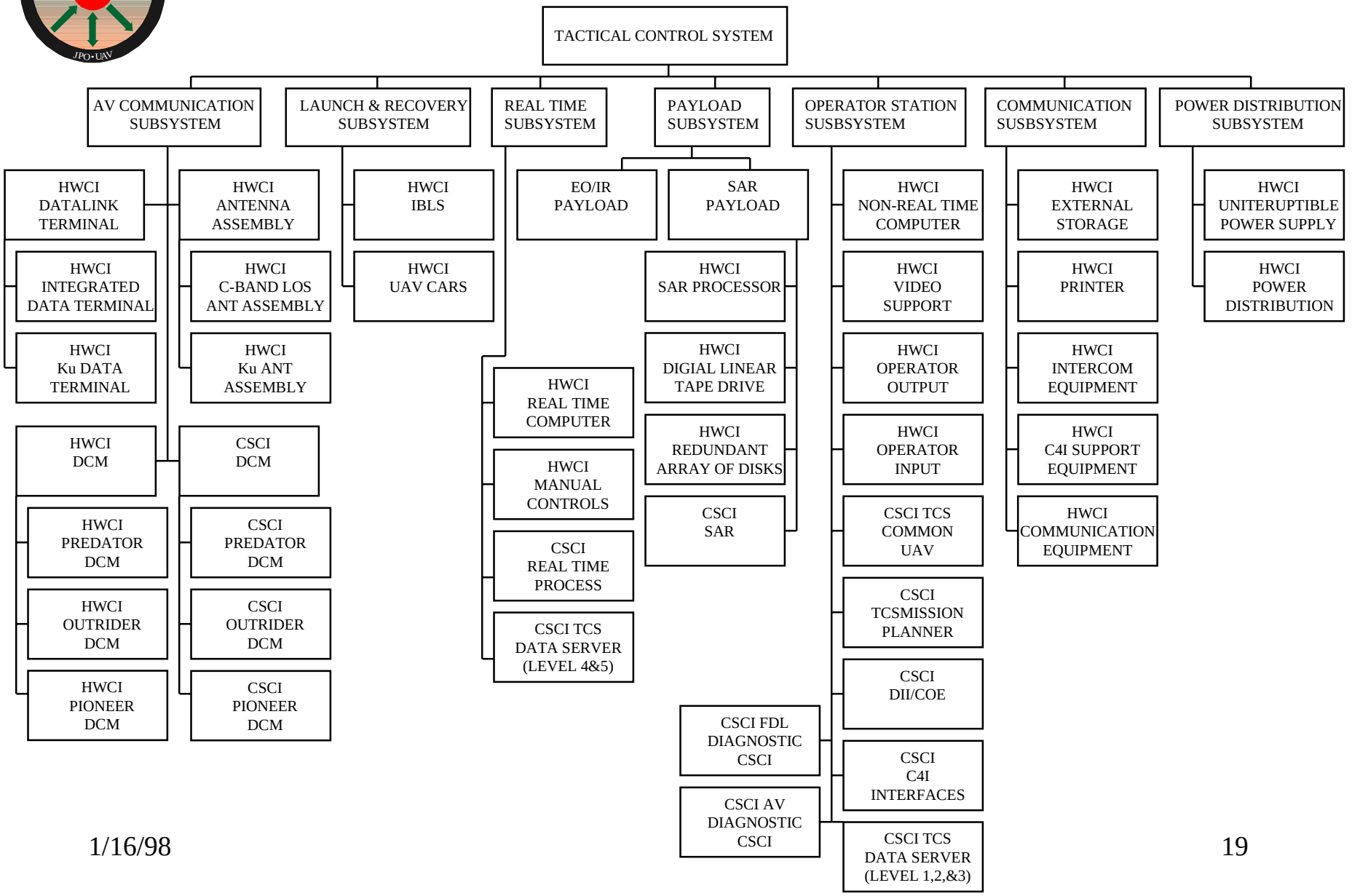
ALLOCATION OF RELIABILITY REQUIREMENTS



ALLOCATION OF RELIABILITY



RELIABILITY REQUIREMENT

$$\textbf{FAILURE RATE} = \frac{\textbf{\# of Failures}}{\textbf{Total Operating Time}}$$

LMA - 1500 hours

Failures - 1

$$\frac{1}{1500} = \textbf{0.0006}$$

$$\textbf{MTBF} = \frac{1}{\textbf{Failure rate}} = \frac{1}{0.006} = \textbf{1666 Hours}$$

RELIABILITY REQUIREMENT
SYSTEM PERFORMANCE

$$\textbf{FAILURE RATE} = \frac{\textbf{\# of Failures}}{\textbf{Total Operating Time}}$$

TCS JWID 97 $\quad \frac{\textbf{2}}{\textbf{139.1}} = \textbf{0.0144}$

$$\textbf{MTBF} = \frac{\textbf{1}}{\textbf{Failure rate}} = \frac{\textbf{1}}{\textbf{0.0144}} = \textbf{69.4 Hours}$$

RELIABILITY REQUIREMENT
HWCI Reliability Values

HWCI	Ao	MTBF	MTTR	HWCI	Ao	MTBF	MTTR
Datalink Terminal	TBD	TBD	TBD	Non-Real Time Computer	TBD	TBD	TBD
Antenna Assembly	TBD	TBD	TBD	Video Support	TBD	TBD	TBD
Datalink Control Module	TBD	TBD	TBD	Operator Output	TBD	TBD	TBD
IBLS	TBD	TBD	TBD	Operator Input	TBD	TBD	TBD
UAV CARS	TBD	TBD	TBD	External Storage	TBD	TBD	TBD
Real Time Computer	TBD	TBD	TBD	Printer	TBD	TBD	TBD
Manual Control	TBD	TBD	TBD	Intercom Equipment	TBD	TBD	TBD
SAR Processor	TBD	TBD	TBD	C4I Support	TBD	TBD	TBD
Digital Linear Tape Drive	TBD	TBD	TBD	Communication Equipment	TBD	TBD	TBD
Redundant Array of Inexpensive Disks	TBD	TBD	TBD	Uninteruptible Power Supply	TBD	TBD	TBD
Link Manager Assembly	TBD	TBD	TBD	Power Distribution	TBD	TBD	TBD

ATWCS TCG Replacement
TAC-3 Equipment ATWCS Experience MTBFs

Item	MTBF
HP755 CPU	50,300
64 MB RAM	869,800
G1 Graphics Card	352,100
G2 Graphics Card	91,000
Video Monitor	152,300
LCD Display	13,000
Keyboard	152,300
Trackball	25,400
2 GB RDD	124,400
1 GB CD ROM	91,000
FDDI Card	176,000
HIL Extender	487,600
4MM DAT Tape Drive	44,000
8 Port Asynch MUX	93,500
TTPS Expansion Chassis	135,000
TWC Expansion Chassis	91,000
MIL-188/RS-232 Converter	654,800

ATWCS LCG Replacement
GFE Equipment Reliability - ATWCS Experience/Predictions

Equipment	Prediction	Prediction Source: Demonstrated(1)	Prediction Source: Prediction(2)
HP J210 CPU	50,300	ATWCS Experience	
HP 743/100 CPU	62,000		Similarity
32 MB RAM	1,739,600		Similarity
64 MB RAM	869,800	ATWCS Experience	
128 MB RAM	434,900		Similarity
FDDI	176,000	ATWCS Experience	
10 Base 2 Ethernet	100,000		Estimate
G1 Graphics	352,100	ATWCS Experience	
G2 graphics	352,100		Similarity
NTDS Type A/B	148,300	ATWCS Experience	
NTDS Type E	57,700	ATWCS Experience	
Video Monitor	152,300	ATWCS Experience	
Keyboard	152,300	ATWCS Experience	
Trackball	25,400	ATWCS Experience	
CD-ROM	91,000	ATWCS Experience	
4MM DAT Drive	44,000	ATWCS Experience	
2GB RDD	114,400	ATWCS Experience	
16 Port MUX	93,500	ATWCS Experience	
MIL-188C/RS-232 Converter	654,800	ATWCS Experience	
UPS, TTPS/LCPS/WPC	19,300	ATWCS Experience	
Power Control Panel	100,000		Estimate

Notes:

(1) Predictions based on ATWCS Experience of similar TCG Replacement equipment.

(2) Predictions based on supplier estimates or SEIA estimates for similar equipment.

BACK- UP

SUPPORTABILITY (LSA) ANALYSIS

Basic Function	**Method Functions**
Establish Supportability Objectives	Conduct Use Study Compare Similar Systems Identify Existing Support System Characteristics, Capacity, Capability
Optimize the Support System for Cost, Schedule, Performance and Supportability	Identify Functional Requirements for Operation and Maintenance Identify Alternative Methods of Support

SUPPORTABILITY (LSA) ANALYSIS

Basic Function

Method Functions

Conduct Reliability Centered Maintenance Analysis and Determine Preventive Maintenance Requirements

Conduct Failure Modes, Effects, and Criticality Analysis

Evaluate and Optimize Support Alternatives

SUPPORTABILITY (LSA) ANALYSIS

Basic Function	Method Functions
Determine Support Resource Requirements	Conduct Task Analysis Evaluate Trials and Early Fielding Performance
Assess Supportability	Define Support System Performance Parameters Define Test and Trials Procedures Conduct Test and Trials and Assess/Report Results

SUPPORTABILITY ASSESSMENT
MAINTAINABILITY

Basic Function	**Method Functions**
Allocate Task to Level of Maintenance	Predict Maintenance Task Times Conduct Level of Repair/Discard Analysis
Assess Design Maintainability	Describe Maintenance Task Procedures Define Removal Rates and Accessibility Requirements/Deficiencies Consider Design Enhancements

RELIABILITY ASSESSMENT

Basic Function	Method Functions
Compare Predicted Reliability of Design Alternatives	Develop Functional Block Diagram Develop Reliability Block Diagram Assign Component Failure Rates Calculate and Compare Predicted Reliability for each Alternative
Provide Estimates for Element Quantities	Identify MTBF for each Functionally Significant Item in the Equipment List

LIFE CYCLE COST PROJECTION

Basic Function

Minimize Cost of Ownership amongst Alternative Design/ Support Systems

Method Functions

Prepare Life Cycle Cost Model
Allocate Project Specific Data
Conduct Sensitivity Analysis in of Uncertainty

OPERATIONAL TASK ANALYSIS

OPERATIONAL TASK ANALYSIS BOUNDARY CONDITIONS

- The skill level of the TCS operator(s) is not germane
- TCS operators will be trained to TCS required standards
- The OTA will address TCS development through TCS Interactivity Level 4, “flight control by autopilot.”
- The integration and functionality of automated takeoff and landing with the controlled UAV platforms is not well enough developed to support this current task analysis.
- A TCS Level 5 analysis will be addressed as a later component of follow-on efforts.

OPERATIONAL TASK ANALYSIS BOUNDARY CONDITIONS

- The OTA will focus on tasks involved in the command, control, data receipt, processing, export and dissemination of the current and future family of UAVs and their products.
- The analysis does not address the functions of maintenance and training.

OPERATIONAL TASK ANALYSIS ASSESSMENTS

- The RAD IPT determined that two assessments, criticality and time duration would be conducted using the Task Listing data.
- These two analyses would be of immediate value to the development and requirements efforts.
- It was understood that follow-on efforts such as the Logistics and Training Task Analyses would use the Task Listing data as a source document to conduct a series of more in-depth analyses which would apply a greater number of criteria.

OPERATIONAL TASK ANALYSIS DEVELOPMENT PROCESS

STEP	RESOURCE AND/OR COMPONENT STEPS
IDENTIFY AVAILABLE SOURCES OF OPERATIONAL TASK DATA	Checklists, Directives, Manuals, Handbooks from legacy systems Existing Task Inventories from legacy systems Design engineering documents Subject Matter Experts (SME)
DEFINE SYSTEM	TCS System/Subsystem Specification TCS Operational Requirements Document
DEFINE MISSION	TCS Operational Requirements Document TCS and related UAV CONOPS
BREAK DOWN MISSION INTO MAJOR FUNCTIONAL AREAS	TCS Control and Monitoring Mission Planning AV Control and Monitoring Data Acquisition and Manipulation Targeting C4I

OPERATIONAL TASK ANALYSIS DEVELOPMENT PROCESS

DEVELOP DATA COLLECTION STRATEGY

Implement a "tiger team" of SMEs in each system
Develop a "strawman" document based on SME input

Submit "strawman" to wider OTA working group to refine tasks

BREAK DOWN INDIVIDUAL FUNCTIONAL AREAS INTO JOB TASKS

COLLATE AND REFINE TASKS

Collate several tasks lists and their related system's parameters/data into a "working strawman" document

Submit working document to SMEs to refine, review, reexamine and rewrite as appropriate
Consolidate SME inputs

IDENTIFY SUBTASKS

Submit "melded" strawman document to SMEs to break down job tasks into component steps, sequences, and raw data required for system understanding
Consolidate SME inputs

OPERATIONAL TASK ANALYSIS DEVELOPMENT PROCESS

APPLY ANALYSIS CRITERIA IN SELECTED AREAS

Submit reworked strawman to SMEs for input
Document analysis of criteria

DEVELOP AND VALIDATE DATA

Submit “final” strawman to larger OTA Working Group

COMPLETE REPORT

Submit to Chairman of RAD IPT

CRITICALITY ASSESSMENT

Criticality Scaling Factors

- Criticality was based on a scale of 1-5.
  - 1 being the least critical
  - 5 the most critical.

There was a separate definition of the scaling factors for the "monitoring" parameters, "caution and warning" parameters, and the remaining sections which list Tasks and Procedures.

CRITICALITY ASSESSMENT

- In making their assessment the groups were told to keep in mind two things:

  (1) the analysis covered only TCS Interactivity Levels 1-4 which did not include takeoff or landing. The TCS Operator in this case receives the AV in cruise flight via a handoff procedure;

  (2) TCS operators may not be fully qualified AV Operators. They will have no capability to "hand-fly" the AV. They will control the AV via "autopilot flight modes" only. Additionally, they may have only a limited understanding of AV performance parameters/conditions to apply for troubleshooting or actively remedying unusual flight or unusual mission conditions.

CRITICALITY ASSESSMENT

Scaling Factors -Monitoring

5 - The ability to monitor alphanumerically this control or flight parameter is critical because of one or more of the below conditions:

a. No caution or warning indication is effectively available to indicate an out-of-limit condition. Failure to detect an out-of-parameter condition and then to apply immediate corrective action and/or contact/handoff to the primary controlling GCS, will result in failure of the mission and/or loss of the AV.

CRITICALITY ASSESSMENT

b. An alphanumeric readout of the parameter is essential to validate and backup a critical caution/warning indication and for the operator to take corrective action. The cause of the warnings or cautions that the readout amplifies will result in failure of the mission and/or loss of the AV without immediate corrective action and/or contact/handoff to the controlling GCS.

c. Monitoring is absolutely essential to maintain situational awareness or to monitor mission progress (position, direction, altitude, heading, airspeed, target location, fuel remaining, etc.).

CRITICALITY ASSESSMENT

3 -

a. The ability to have an alphanumeric reading to monitor this control flight parameter, while not essential, would significantly enhance the ability of the TCS operator to describe an abnormal situation, or to explain to the primary GCS the causes of a caution/warning indication. The out-of-parameter condition is not an immediate threat to flight safety, but will cause a significant degradation to mission success.

b. The ability to monitor this flight parameter would enhance situational awareness, or the ability to monitor mission progress, but is not essential.

CRITICALITY ASSESSMENT

1 -

a. Inability to monitor this flight or control parameter will pose no threat to flight safety. An out-of-parameter condition will pose no/minor degradation to mission success.

b. Inability to monitor the flight parameter would not significantly degrade situational awareness or the ability to monitor mission progress.

CRITICALITY ASSESSMENT

Caution/Warning

5 - The out-of-parameter condition indicated by this warning/caution indication will require the TCS operator to take **immediate corrective action** and/ or contact/handoff to the primary controlling GCS to avoid imminent mission failure and/or loss of the AV

3 - The out-of-parameter condition indicated by this warning/caution indication will pose no immediate threat to safety of flight, and/or the out of parameter condition will result in at least a 50% mission success degradation.

1 - The out-of-parameter condition indicated by this warning/caution indication will pose no threat to flight safety and no/minor degradation to mission success.

CRITICALITY ASSESSMENT

Tasks/Procedures (All remaining sections)

5 -

The consequences of the task being performed incorrectly, or not being performed, will cause a probable mission failure and/ or loss of the Air Vehicle.

3 -

The consequence of incorrect performance, or non-performance, will result in at least a 50% mission success degradation.

1 -

The consequences of non-performance, or incorrect performance, do not pose a significant threat to mission success or safety.

DURATION ASSESSMENT

An assessment was also made concerning the time duration required to accomplish the same major task groupings within the functional areas. Duration was broken down to hours, minutes and seconds (HRS:MIN:SEC). In areas of the OTA where no number appears, the determination was made that either information was not known about the task or that an assessment was not applicable to the task. Section 6 “C4I/TCS Interfaces” is an example where not enough is known about the functionality of the interfaces to make meaningful assessments of duration. No assessments were made for the Control, Monitoring, and Caution and Warning areas of Sections 3 and 4 since they deal with tasks that are momentary in nature, but are executed continuously throughout the entire flight of the AV.

C4I OPERATIONAL TASK ANALYSIS

TASK NUMBER	TASK	TCS LEVEL 1 TO 5	PLATFORM All AV's unless noted (Sec 6 only)	REMARKS	CRITICALITY 1-5	DURATION (HR:MIN:SEC)
6.0	**C4I/TCS INTERFACE**					
6.1	**Transmission to C4I**					
6.1.1	**Xmit recorded Analog Imagery**		1,2,3,4,5		1	
6.1.1.1	Rewind VCR to correct tape location		1,2,3,4,5			
6.1.1.2	Route VCR output to external RS-170 port		1,2,3,4,5			
6.1.1.3	Switch VCR output to "tape"		1,2,3,4,5	VCR output stream can be toggled between"tape" and "input"		
6.1.1.4	Switch VCR to "play"		1,2,3,4,5			
6.1.1.5	Select secure/non-secure		1,2,3,4,5			
6.1.1.6	Monitor VCR counter		1,2,3,4,5			
6.1.1.7	Switch VCR to "stop"at end of tape sequence		1,2,3,4,5			
6.1.1.8	Forward VCR to beginning of unrecorded tape section		1,2,3,4,5			
6.1.1.9	Log transmission details		1,2,3,4,5			
6.1.2	**Xmit real-time analog imagery**		2,3,4,5	Assumes that analog imagery is routed through VCR to external port, like a home TV)	3	
6.1.2.1	Route analog signal to external RS-170 port		2,3,4,5			
6.1.2.2	Switch VCR input to TCS Workstation		2,3,4,5	VCR input can be toggled between TCS workstation and external RS-171		
6.1.2.3	Select overlay/no overlay		2,3,4,5			